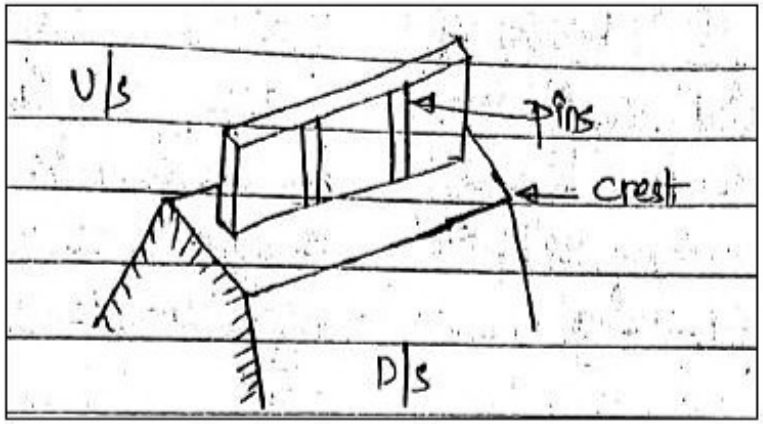
❑ **Spilling gates:** (Gates may be automatic or manually operated)

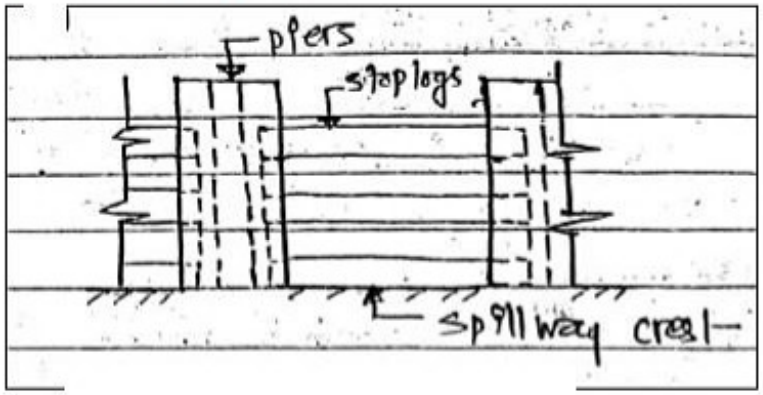
❖**Types of gates:**

1. Flashboards:



- Temporary gates having wooden panels supported by vertical pins embed on crest.
- When the level reaches to certain height, flash boards fail & to be replaced for next flood.

2. Stoplogs:



-Horizontal layers of loose timbers placed in betn. Piers.

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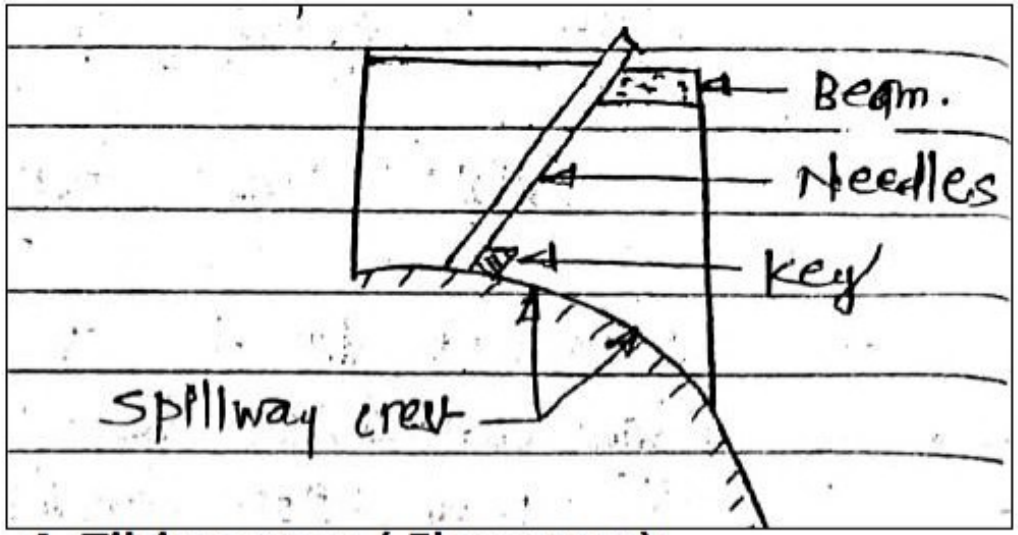
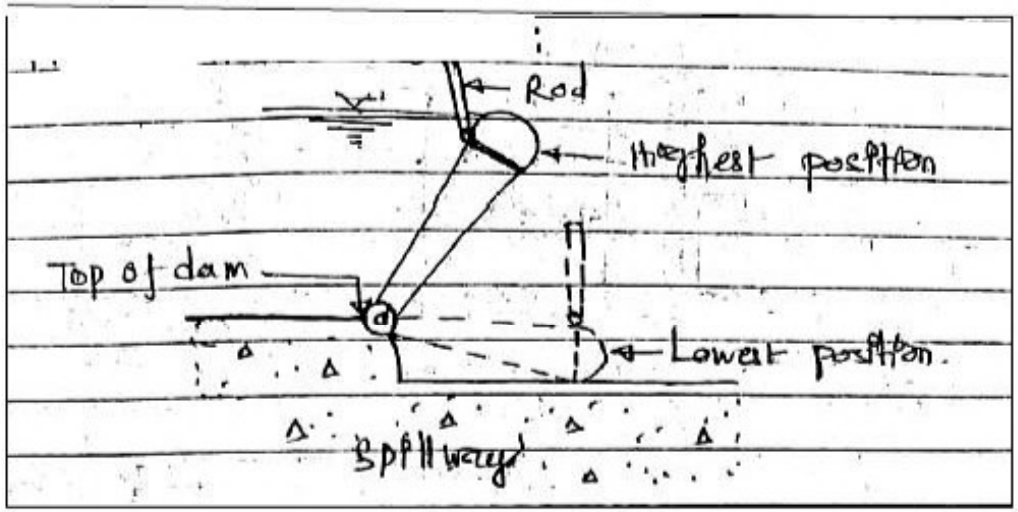
3. needles:



Incline row of loose timbers are supported at bottom by key in the spillway as shown in figure.

4. Tilting gates (Flap gates):



The upper edge can be moved with the help of rod about the lower hinge to pass the flood over the crest.

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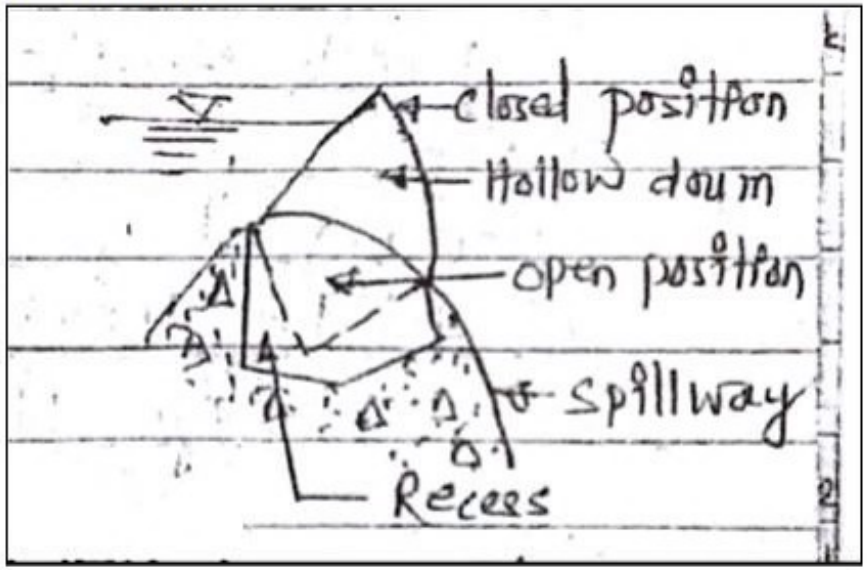
5. Drum gate:



-Useful to pass the debris, ice in large amount.
- For lifting the gate in its closed position, water is admitted to the recess to create a buoyant force.

6. **Vertical lift gate:**

For passing flood the gate is lifted vertically so that water passes underneath the gate.

7. Rolling gate:

When the gate is hoisted up, it roll on a rack.

8. Radial (or Tainter) gate:

Face of gate is sector supported on a steel framework which is pivoted on the spillway crest.

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9. Automatic vertical lift gate:

A 'counter weight' in a reservoir balances the gate in position under normal condition. When the water level rises in reservoir the the 'counter weight' becomes lighter due to buoyant force and gate slides down from the crest, opening the gate.

❑Cavitation:

The crest of the spillway can be made to conform only to one particular 'nappe' that would be obtained at one particular head. This head is called the designed head (H_d). But in practice the actual head of water on the spilling crest , called operating head (H_o), may be less or more than design head (H_d).

- If $H_o < H_{d,}$ lower nappe would adhere to the crest of the ogee spillway.
- If $H_o > H_{d,}$ Lower nappe of the falling jet may leave the ogee profile, thereby generating –ve pressure at the point of separation. The generation of vacuum pressure may lead to formation of air bubbles of cavities in the water. Such bubbles on moving downstream may enter a region where atmospheric pressure much higher than –ve pressure. Now, these bubbles collapse and extremely high pressures are generated. This causes formation of pits on its surface and giving the surface a spongy appreance. This damaging action of cavitation is called 'Pitting'.

❖Cavitation control:

- Make smooth curve surface of crest.
- Air supply to prevent the formation of –ve pressure.

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The *cone dispersion* (Howell–Bunger) valve (Fig. 6.6) is probably the most frequently used type of regulating valve installed at the end of outlets discharging into the atmosphere. It consists of a fixed 90° cone disperser, upstream of which is the opening covered by a sliding cylindrical sleeve. It has been used for heads of up to 250 m, and when fully open its discharge coefficient is 0.85–0.9. The fully opened valve area is about 0.8 of the conduit area.

The Howell–Bunger valve is cheaper, less robust but more reliable and with a better discharge coefficient than the needle or hollow-jet valves, and should really be used in dam design only when discharging into the atmosphere (although in some special cases it has been used in conduits followed by a ring hydraulic jump (Haindl, 1984)). The fine spray associated with the operation of the valve may be undesirable, particularly in cold weather; sometimes, therefore, a fixed large hollow cylinder is placed at the end of the valve downstream of the cone, resulting in a ring jet valve. The discharge coefficient is reduced in this case to about 0.75–0.80.

The *needle* valve, (and its variation the *tube* valve), has a bulb-shaped fixed steel jacket, with the valve closing against the casing in the

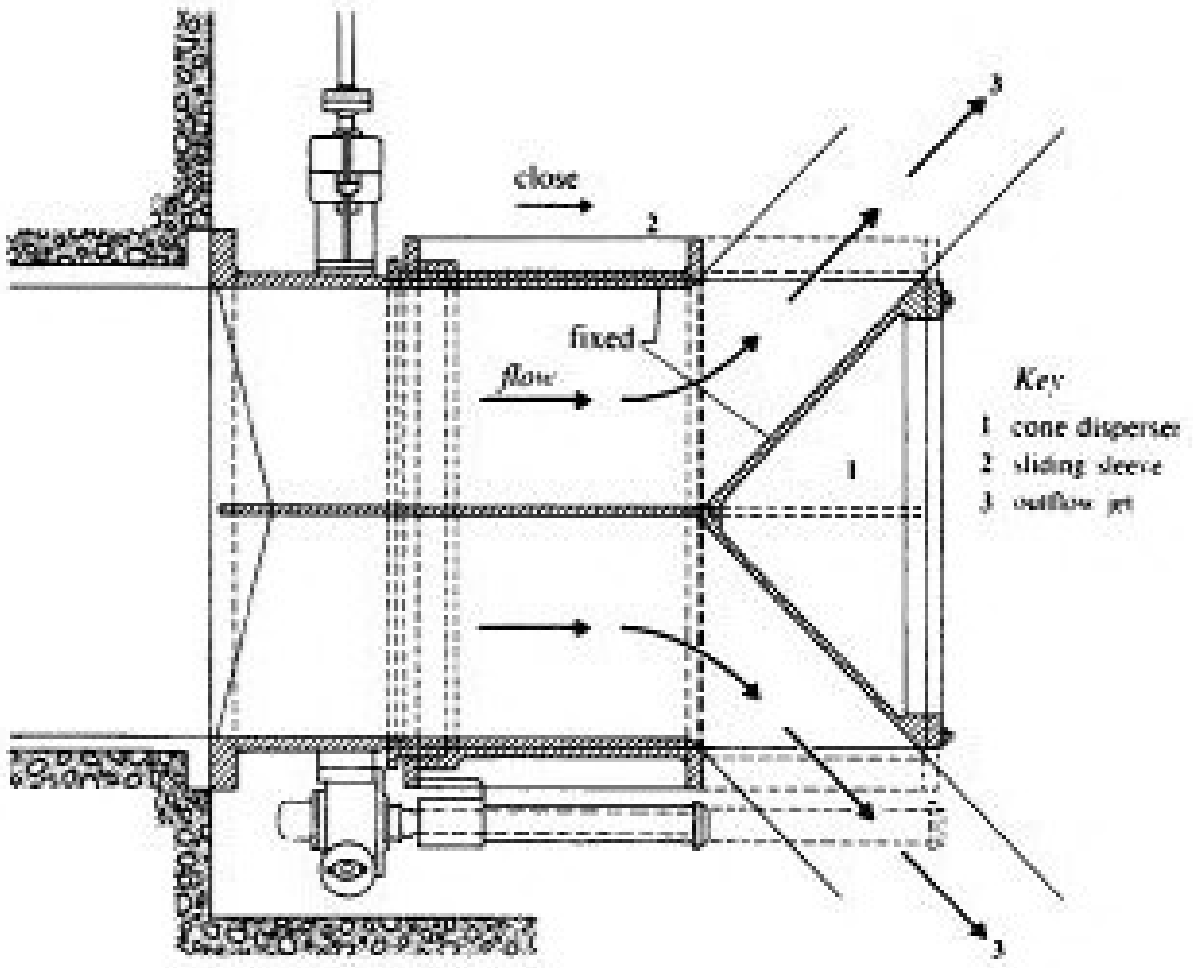

Fig. 6.6 Cone dispersion valve (after Smith, 1978)

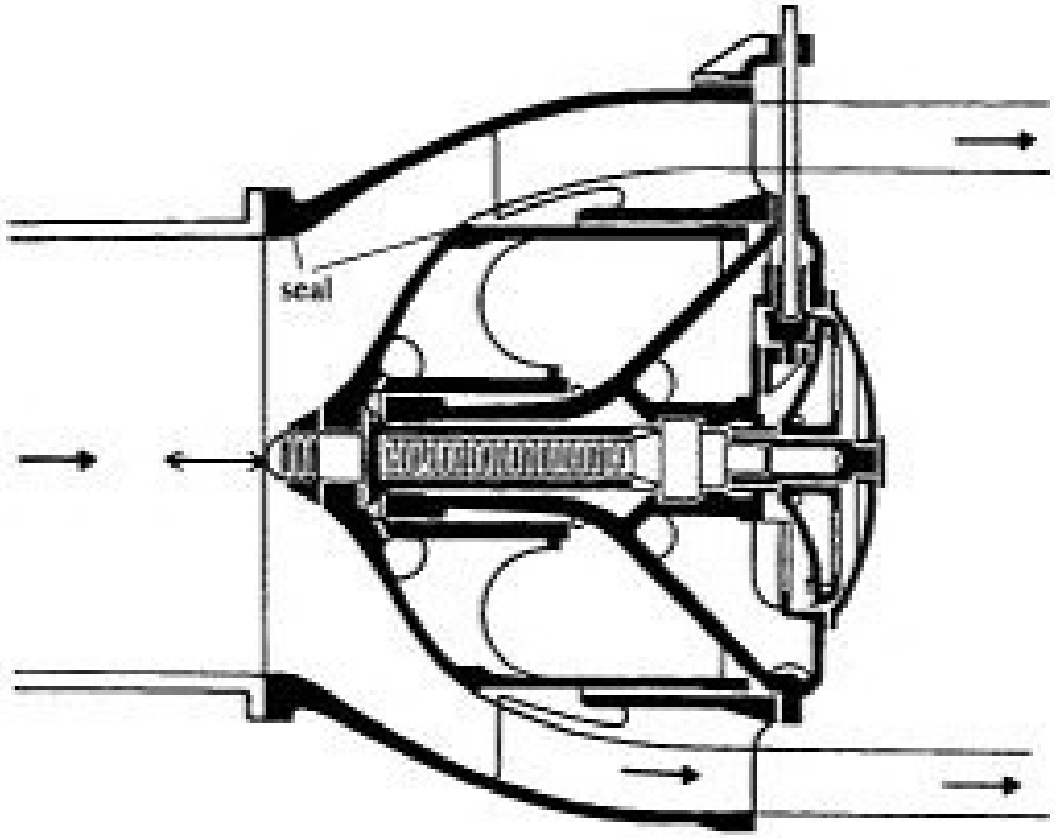

Fig. 6.7 Hollow-jet valve (after Smith, 1978)

downstream direction. When open, the valves produce solid circular jets and can also be used in submerged conditions. The valves may suffer from cavitation damage and produce unstable jets at small openings, and are expensive as they have to withstand full reservoir pressures.

Most of those disadvantages are overcome in the *hollow-jet* valve (Fig. 6.7), which closes in the upstream direction (when closed the valve body is at atmospheric pressure); because of this the valve is, of course, not suitable for use in submerged conditions. The discharge coefficient of the fully open valve is about 0.7.